DOCUMENT RESUME

ED 277 745 TM 870 024

TITLE	Mathematics, Grade 5. TEAMS Instructional Strategies Guide.
INSTITUTION	Texas Education Agency, Austin.
PUB DATE	Aug 86
NOTE	60p.; For related documents, see TM 870 022-039.
AVAILABLE FROM	Texas Education Agency, William B. Travis Building, 1701 North Congress Avenue, Austin, TX 78701
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	Basic Skills; *Behavioral Objectives; Computation; Elementary School Mathematics; Geometry; *Grade 5; Instructional Development; Intermediate Grades; Learning Activities; *Learning Strategies; *Mathematics Instruction; Mathematics Skills; *Mathematics Tests; *Minimum Competency Testing; Number Concepts; Problem Solving; State Programs; Teaching Guides; Testing Programs; Test Items
IDENTIFIERS	Test Content; *Texas Educational Assessment of Minimum Skills

ABSTRACT

The Texas Educational Assessment of Minimum Skills (TEAMS) was developed by the Texas Education Agency (TEA), in response to Texas House Bill 72 (1984), which mandated a new basic skills assessment program for mathematics, reading, and writing at grades 1, 3, 5, 7, 9 and 11. This document is one in a series of Instructional Strategies Guides designed to familiarize Texas educators with the types of strategies employed in assessing learner mastery of TEAMS objectives and to provide suggested instructional activities that can be used to promote mastery of those objectives. This guide focuses on the TEAMS mathematics objectives for grade 5. It provides a detailed description of the test items used to measure each mathematics objective. The 11 objectives are subsumed under five skill areas: (1) number concept (place value, equivalent fractions); (2) computation (addition and subtraction of decimals, multiplication of whole numbers, division of whole numbers); (3) problem solving (word problems involving addition and subtraction of whole numbers, multiplication and division of whole numbers, addition and subtraction of decimals); (4) measurement (metric and customary units, graphs); and (5) geometry (perimeter and area of polygons). The following information is provided for each objective: (1) a description of objective; (2) a sample item; (3) test questions; (4) answer choices; (5) answer analyses sample item; (6) instructional emphases; and (7) possible instructional activities. (JAZ)

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INSTRUCTIONAL STRATEGIES GUIDE

MATHEMATICS

GRADE 5

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August 1986

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TEAMS INSTRUCTIONAL STRATEGIES GUIDE

MATHEMATICS

GRADE 5

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ACKNOWLEDGMENTS

Under contract with the Texas Education Agency, the Information Services Division of National Computer Systems subcontracted with IOX Assessment Associates to develop this TEAMS instructional strategies guide.

Key reviewers of early drafts of the guide were Lisa Chandler, Ramona Jo DeValcourt, Norlene M. Kunkel, Cathy Seeley Peavler, and Patricia Sachse Porter of the Texas Education Agency.

INTRODUCTION

During 1980-1985 the Texas Education Agency (TEA) administered a criterion-referenced testing program, the Texas Assessment of Basic Skills (TABS). That program was designed to measure minimum skills in mathematics, reading, and writing at Grades 3, 5, and 9. In July 1984, under the provisions of House Bill 72, a new basic skills assessment program was mandated in mathematics, reading, and writing at Grades 1, 3, 5, 7, 9, and 11. In response, development of the Texas Educational Assessment of Minimum Skills (TEAMS) was instituted by TEA during the 1985-1986 school year.

School district personnel from across Texas participated in all aspects of the development of TEAMS. Basic skills objectives were selected after a thorough review of the State Board of Education Rules for Curriculum, GE4 450 01 (Essential Elements). Under TEA supervision measurement specifications and test items were developed for each objective. Statewide field testing was conducted to ensure the quality of test items. The State Board of Education then approved the TEAMS tests for administration.

Because of the significance of the TEAMS program, TEA is providing Texas educators with instructional strategies guides for all objectives measured on each TEAMS examination. These guides describe the TEAMS objectives as well as instructional considerations and activities that can be used to promote mastery of TEAMS objectives.

This instructional strategies guide focuses on the TEAMS mathematics objectives for Grade 5. It provides a detailed description of the test items used to measure each mathematics objective. In addition, a brief instructional analysis is provided for each objective as are instructional activities that can help students master the objective.

Texas educators will undoubtedly vary in the ways they wish to promote learner mastery of the TEAMS objectives. Thus, the instructional components of this guide are <u>not</u> intended to be prescriptive. Teachers should view suggested activities as potential approaches that lead to mastery of the TEAMS objectives.

Components of the Instructional Strategies Guide

Eleven TEAMS mathematics objectives are measured at the fifth grade level. These objectives are subsumed under one of five skill areas. The distribution of mathematics objectives by skill area is shown on the next page.

SKILL AREA	OBJECTIVE
Number Concepts	Place Value Equivalent Fractions
Computation	Addition and Subtraction of Decimals Multiplication of Whole Numbers Division of Whole Numbers
Problem Solving	Addition and Subtraction of Whole Numbers Multiplication and Division of Whole Numbers Addition and Subtraction of Decimals
Measurement	Metric and Customary Units Graphs
Geometry	Perimeter and Area of Polygons

This guide provides the following information for each of the mathematics objectives included in the TEAMS Grade 5 test.

Description of the objective. This section provides a succinct overview of the objective's focus.

Sample item. An illustrative sample item follows the description of each objective. This item is consistent with the test specifications for the objective, hence is representative of the Teams items used to measure students' mastery of the objective.

Test questions. To provide a more detailed view of how each TEAMS objective is assessed, the next section provides a description of the test question. All of the Grade 5 mathematics items present a stimulus that precedes four answer choices.

Answer choices. The next section deals with the response to each multiple-choice test item. Important characteristics of the answer choices are described.

Answer analysis for sample item. An analysis of the answer choices from the sample item is then provided. This analysis explains why the correct answer is right and why the incorrect answers are wrong.

Instructional emphases. Considerations relevant to the design of instructional sequences for each TEAMS objective are described in this section. These instructional analyses are not intended to represent the only important points associated with

instruction aimed at a particular objective. However, it is hoped that these discussions will stimulate educators' consideration of each objective.

Possible instructional activities. A final section discusses several instructional activities for each objective that Texas educators may consider as they organize their instructional plans.

Use of the Instructional Strategies Guide

This TEAMS instructional strategies guide is designed to accomplish two goals. First, the guide enables Texas educators to become familiar with the types of strategies employed to assess learner mastery of the TEAMS Grade 5 mathematics objectives. Educators who wish to learn more about how the TEAMS objectives are tested should consult the TEAMS objectives and measurement specifications available at cost from TEA. The level of detail provided in this instructional strategies guide should provide sufficient information for educators to design effective instructional sequences. Second, each instructional strategies guide provides suggestions for instructional activities that can be used to promote mastery of TEAMS objectives.

The specific setting in which a given district chooses to provide instruction in the TEAMS objectives, of course, will influence the way in which the materials in this guide can be employed. The format of the guide permits flexible use.

General Nature of the Test Items

The TEAMS Grade 5 objectives are measured by multiple-choice items that present a problem followed by four answer choices, one of which is correct. The items, depending on the objective, present a graphic or tabular display, a geometric figure, a numeric problem, or a word problem. The problems are similar to those that students encounter in school, at home, or in their community.

SKILL AREA: NUMBER CONCEPTS

The skill area of number concepts covers two objectives: place value and equivalencies.

Objective 1: Interpret place value in whole numbers and decimals having no more than five digits.

This objective requires students to interpret place value in whole and decimal numbers having no more than five digits.

Sample Item

In the number 62.81 the value of the 6 is_____.

A. 60

B. $\frac{6}{10}$

C. 6000

D. 6

Test Questions

1. A test item will be in either of the following two formats:

   a. "In the number [a number] which digit is in the [a place value] place?"

   b. "In the number [a number] the value of the [a digit] is _____."

2. The numbers will be whole and decimal numbers that do not exceed five digits. Decimal numbers will have no more than two digits to the right of the decimal place. The numbers will not contain any repetition of digits. Only five-digit whole numbers will have commas.

Answer Choices

1. The correct answer choice will either be the face value or total value of a digit in a specified place value.

2. Incorrect answer choices will be either:

   a. the value of a digit in a position other than the place specified, or

   b. a digit that occupies a place other than the one specified.

Answer Analysis for Sample Item

1. Answer choice A is the correct response. The total value of the 6 in the number 62.81 is 60. This is calculated by multiplying the face value (6) by the appropriate place value (tens): 6 x 10 = 60.

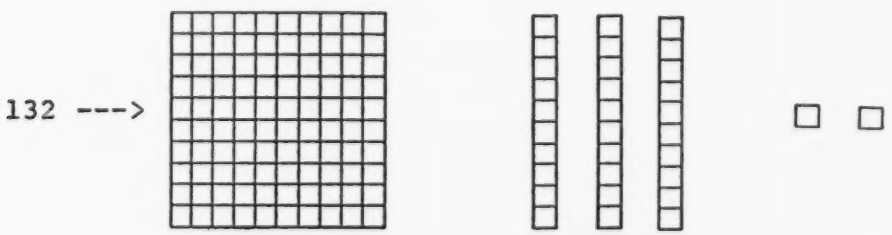
2. Answer choice B is incorrect. It appears that the correct face value (6) was multiplied by an incorrect place value ($\frac{1}{10}$): $6 \times \frac{1}{10} = \frac{6}{10}$. The 6 occupies the tens, not the tenths, place.

3. Answer choice C is also incorrect. It appears that an incorrect place value was used to calculate the total value of the digit. The 6 does not occupy the thousands place; therefore, it is not appropriate to multiply 6 by 1000 to obtain 6000.

4. Answer choice D is incorrect because an incorrect place value was used to calculate the answer. The ones place was used, rather than the tens place, yielding the incorrect total value: $6 \times 1 = 6$.

Instructional Emphases

Review the concept of place value by using place value models. For example, write a three-digit number such as 132 on the chalkboard. Ask students to tell you what each digit in the number represents. Then, represent the number with prepared place value models (sheets, strips, and individual boxes), as follows:



1 hundred 3 tens 2 ones

Present various numbers to the class using place value models. You may also wish to give groups of students their own models with which to work. After students appear comfortable with the concept of place value, introduce a place value chart such as the one shown below. Incorporate the ten thousands and thousands places on the chart. Demonstrate how different numbers can be represented in the chart.

	10,000 Ten thousands	1000 Thousands	100 Hundreds	10 Tens	1 Ones
17,483	1	7	4	8	3
2650	0	2	6	5	0
etc.					

Proceed by explaining that the concept of place value is applicable to decimal numbers as well as whole numbers. Decimal numbers contain a decimal point to the right of the ones place. Place values continue to the right of the decimal point as tenths, hundredths, etc. Incorporate these decimal values in a place value chart such as the one shown below. Present decimal numbers for students to put in the chart. Have students explain why each digit occupies a particular place.

	100 Hundreds	10 Tens	1 Ones	•	Tenths	Hundredths
362.18	3	6	2	•	1	8
56.89	0	5	6	•	8	9
etc.						

You may also wish to reinforce the concept of decimal places by using money or place value blocks.

In addition, it may be helpful to introduce the concepts of face value and total value. Using number examples from the place value chart, discuss the following definitions:

place value - the value based on a digit's location in a number (for example, the tens place value = 10)

face value - the value of a digit independent of its place in a number (for example, the face value of 6 = 6)

total value - the total value of a digit, that is, its face value multiplied by its place value (for example, in the number 362 the total value of the 6 is 6 x 10 or 60 because 6 tens represents 60).

Possible Instructional Activities

Math Trivia

Distribute a sheet of facts, such as the following:

(1) Highest mountain - 29,031 feet (Mt. Everest)
(2) Highest water fall - 3210 feet (Angel Falls)
(3) Number of square miles in Wichita Falls, Kansas - 49.2 square miles
(4) Highest dam - 1098 feet (Rogun)
(5) Longest river - 4150 feet (Nile River)
(6) Average weight of a 10-year old girl - 32.56 kilograms
(7) Number of nations in the world - 178
(8) Number of hours in a year - 8760 hours
(9) Average height of a 10-year old boy - 127.85 centimeters
(10) Smallest state in the United States - 1209 square miles (Rhode Island)

Call on students individually to answer questions about each number fact, such as:

1. What is the value of a certain digit?

2. What digit is in the hundredths (tenths, ones, tens, hundreds, thousands, or ten thousands) place?

Discuss and elaborate on each answer as needed.

Place Value Clues

Distribute copies of the following worksheet to students.

Number	Which digit is in the the _____ place?	Digit	Code
17,428	ten thousands	1	G
5,162	tens		
521.6	tenths		
8974.5	ones		
4675.1	thousands		
38,952	ten thousands		
164.32	hundredths		
9548.9	hundreds		
67,493	ten thousands		
981.42	hundredths		
357.68	tenths		
9687.3	ones		

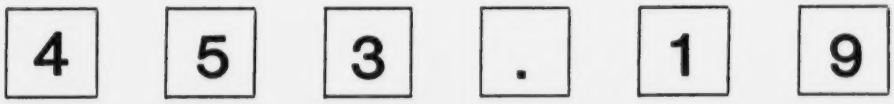
Code

1=G 2=Y 3=A 4=D 5=T 6=O 7=U

Tell students to fill in the column of the chart labeled "Digit" with the digit that holds the place value specified for each number. When each digit has been identified, have students use the code provided below the chart to assign a letter to each digit. If each problem is answered correctly, a message can be read down the code column of the chart.

Know Your Place

Use either commercial flash cards or student-made cards for this activity. Each card should present a digit (from 0 to 9) or a decimal point. Choose five or six students to stand in a line at the front of the class. Have each student pick one flash card. For a line of five students, pass out one digit card to each student. In a line of six students, pass out 3 digit cards, 1 decimal point card, and then 2 more digit cards, respectively. (See illustration below.)



Then ask the seated students to answer two types of questions:

1. What is the value of [a certain digit]?

2. What digit is in the [ten thousands, thousands, hundreds, tens, ones, tenths, or hundredths] place?

You may want to have the standing line of students "rearrange themselves" to make a new number. (Remember, however, that TEAMS does not include numbers with more than two places to the right of the decimal point.) The "rearranging process" provides a good demonstration of how the face value of a digit always remains the same, while the place value changes depending on the digit's location in a number.

Objective 2: Identify equivalent fractions.

This objective requires students to identify equivalent fractions or fractional parts of pictorial models.

Sample Item

Which fraction means the same as $\frac{2}{6}$?

A. $\frac{3}{7}$

B. $\frac{6}{2}$

C. $\frac{1}{3}$

D. $\frac{5}{2}$

Test Questions

1. Test items will consist of two types of questions in which students must identify:

   a. a fraction that is equivalent to a specified fraction, or

   b. a part of either a whole or a group of like objects presented pictorially that is equivalent to a specified fraction

2. Equivalent fractions and pictorial representations will be limited to halves, thirds, fourths, fifths, sixths, eighths, tenths, twelfths, and sixteenths. No mixed fractions will be used or represented.

3. Incorrect answer choices are likely to result from one or more of the following types of errors:

   a. Computation Error: An error in the multiplication or division of two numbers.

   b. Incorrect Simplification: Incorrectly simplifying a fraction.

   c. Incorrect Operation: Performing an operation other than the one required.

d. Reciprocal Error: Incorrectly identifying the reciprocal of a fraction as its equivalent.

Answer Analysis for Sample Item

1. Answer choice A is incorrect because of an incorrect operation. Both the numerator and the denominator of $\frac{2}{6}$ were increased by 1 to obtain the incorrect answer, $\frac{3}{7}$.

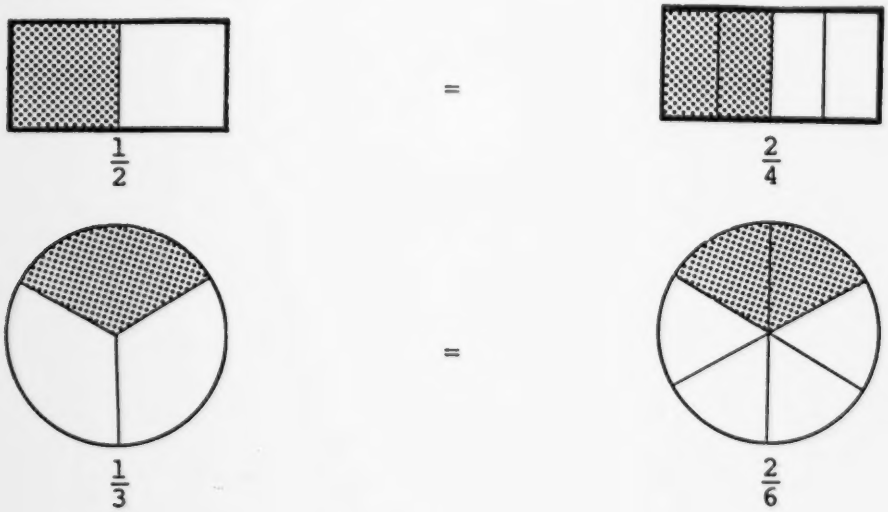
2. Answer choice B is incorrect because of an error involving a reciprocal fraction. The reciprocal of the fraction $\frac{2}{6}$, (namely, $\frac{6}{2}$) is incorrectly identified as its equivalent.

3. Answer choice C is correct. The fraction $\frac{1}{3}$ is equivalent to $\frac{2}{6}$. When both the numerator and denominator of $\frac{2}{6}$ are divided by 2, the resulting equivalent fraction is $\frac{1}{3}$.

4. Answer choice D is incorrect because of a computation error in the denominator. The product of 2 x 2 is 4, not 5.

Instructional Emphases

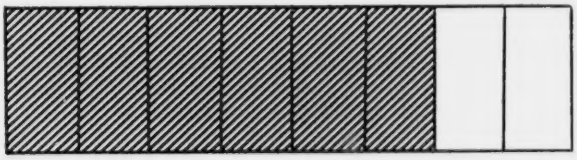
Success with this objective requires an understanding of the concept of equivalency among fractions. Explain to students that fractions referring to the same amount are called equivalent fractions. Illustrations and models, as represented below, should be used to develop the concept of equivalent fractions. Students should have ample experience with models before proceeding to the use of rules.



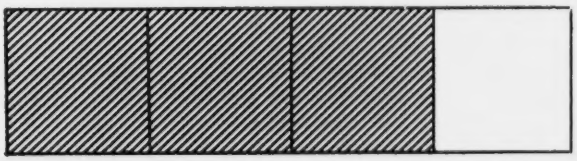
$\frac{1}{2}$ $\frac{2}{4}$

$\frac{1}{3}$ $\frac{2}{6}$

Next, show students how to find equivalent fractions. One way to find equivalent fractions is by division. Specifically, to obtain an equivalent fraction, divide the numerator and denominator of a fraction by a common factor (that is, a number that can be evenly divided into both numbers). Demonstrate this procedure by drawing a pair of shapes on the chalkboard that represent equivalent fractions. For example:



$\frac{6}{8}$



$\frac{3}{4}$

Show that the fraction $\frac{3}{4}$ can be obtained from $\frac{6}{8}$ by dividing both 6 and 8 by the common factor 2.

$$\frac{6}{8} = \frac{6}{8} \div (\frac{2}{2}) = \frac{6 \div 2}{8 \div 2} = \frac{3}{4}$$

Explain that equivalent fractions can also be obtained by multiplication. To produce an equivalent fraction, multiply both the numerator and denominator by the same nonzero number. (Zero should not be used because any number multiplied by zero equals zero, and a zero in the denominator of a fraction is undefined.) Using the above example, $\frac{6}{8}$ can be obtained from $\frac{3}{4}$ by multiplying 3 and 4 by the same number, 2.

$$\frac{3}{4} = \frac{3}{4} \times (\frac{2}{2}) = \frac{3 \times 2}{4 \times 2} = \frac{6}{8}$$

Emphasize to students that only multiplication and division are used to obtain equivalent fractions. These operations work because dividing or multiplying both the numerator and denominator of a given fraction by the same number is equivalent to multiplying or dividing that fraction by 1 (in the above examples $\frac{2}{2} = 1$). Multiplying or dividing any number by one yields that same number.

Finally, you may want to introduce students to the idea of using cross-products to verify that two fractions are equivalent. Demonstrate that when two fractions are equivalent, their cross-products are the same. For example, to verify that $\frac{2}{3} = \frac{4}{6}$, their cross-products are found as follows: $\frac{2}{3}\times\frac{4}{6}$. Specifically, the numerator of the first fraction is multiplied by the denominator of the second fraction ($2 \times 6 = 12$), and the denominator of the first fraction is multiplied by the numerator of the second fraction ($3 \times 4 = 12$). Because both cross-products equal 12, it can be concluded that the two fractions are equivalent.

Possible Instructional Activities

Color Me Equal

Distribute a sheet containing pairs of shapes that are equivalent. For each pair, divide the shapes into equal parts, making sure that the number of parts in one shape is a multiple of the number of parts in the other (for example, 2 and 4, 3 and 6, or 2 and 8). Provide a fraction that can be represented in the first shape. Tell students to color in parts of the first shape to represent a given fraction. Then, tell students to identify the equivalent fraction that can be represented in the second shape, and color that shape accordingly. Below are examples of such problems.

In each shape, color in the part that is equivalent to $\frac{1}{2}$.

$\frac{1}{2}$ ____

In each shape, color in the part that is equivalent to $\frac{4}{6}$.

$\frac{4}{6}$ ____

Equivalent or Not?

Distribute the following table to students. Tell them to complete the table by computing the cross-products for each pair of fractions and indicating whether the fractions are equivalent. The first two problems have been completed as models for students.

Fractions	Cross-Products		Are the fractions equivalent?
$\frac{4}{6}$, $\frac{8}{12}$	4 x 12 = 48	6 x 8 = 48	Yes
$\frac{1}{2}$, $\frac{9}{16}$	1 x 16 = 16	2 x 9 = 18	No
$\frac{2}{4}$, $\frac{5}{10}$	_____	_____	___
$\frac{2}{5}$, $\frac{3}{10}$	_____	_____	___
$\frac{4}{5}$, $\frac{5}{6}$	_____	_____	___
$\frac{5}{8}$, $\frac{10}{16}$	_____	_____	___
$\frac{2}{3}$, $\frac{8}{12}$	_____	_____	___

The Outcast

Present students with several groups of fractions in which all but one are equivalent (for example, $\frac{2}{3}$, $\frac{4}{6}$, $\frac{5}{7}$, $\frac{8}{10}$). Ask students to circle the fraction that is not equivalent to the others. For a group activity, you can put the group of fractions on the board and ask students to come to the board and circle the "outcast," or unequivalent fraction.

SKILL AREA: COMPUTATION

The skill area of computation includes three objectives: addition and subtraction of decimals, multiplication of whole numbers, and division of whole numbers.

Objective 3: Add and subtract decimals that have no more than five digits.

This objective requires students to solve addition and subtraction problems involving decimal numbers.

Sample Item

5.37 + .08 = _____

A. 5.45

B. 5.29

C. 13.37

D. 6.17

Test Questions

1. Problems will be displayed horizontally.
2. The maximum number of digits in any one number will be five. No more than two digits will be to the right of the decimal point. In some problems, the numbers to be added or subtracted will have different numbers of places to the right of the decimal point.
3. Addition problems will have no more than three addends.
4. Some problems will require regrouping.
5. Some problems will include dollar signs on the numbers to be added or subtracted.

Answer Choices

1. The correct answer choice will be the exact solution to the addition or subtraction problem presented.

2. The maximum number of digits in any answer choice will be five. No more than three of the digits will be to the right of the decimal point.

3. Incorrect answer choices are likely to result from one or more of the following types of errors:

   a. Computation Error: An error in the addition or subtraction of two numbers.

   b. Regrouping Error: Failing to regroup when necessary, regrouping incorrectly, or regrouping unnecessarily.

   c. Misplaced Decimal Point: Placing the decimal point in an incorrect position on either a correct or incorrect solution.

   d. Misaligned Digit: Adding or subtracting a digit of one place value to or from a digit of an adjacent place value.

   e. Incorrect Operation: Performing an operation other than the required one.

Answer Analysis for Sample Item

1. Answer choice A is the correct response, as illustrated. The addition is accurate, the digits are correctly aligned, and the decimal point is properly placed.

```
 5.37
+ .08
 5.45
```

2. Answer choice B is incorrect because the wrong operation was performed. It appears that .08 was subtracted from 5.37 rather than added to it.

3. Answer choice C is incorrect because the digits were misaligned, as illustrated. The 8 in .08 was aligned with the 5 in 5.37.

```
 5.37
+ 08.
13.37
```

4. Answer choice D is incorrect because the digits were misaligned, as illustrated. The zero was dropped from the addend, .08, and the decimal points were aligned accordingly. This error results in the incorrect final solution.

```
 5.37
+  .8
 6.17
```

Instructional Emphases

It may help students to be reminded that computations for decimal operations are carried out exactly the same as whole number operations. However, you may need to spend some time reviewing the placement of the decimal point. Students should be reminded to align decimal points when setting up addition and subtraction problems. Some students may forget that the decimal point for whole numbers, which is not typically shown, follows the number.

The steps required for addition and subtraction involving decimals are presented below. You may wish to review these steps with students when you present sample problems.

Adding and Subtracting with Decimals

1. Write the problem in vertical format. Align the decimal points of the numbers in the problem. This will ensure that the place-value positions are aligned correctly.

2. To avoid alignment errors, add 0's so that all numbers in a problem have the same number of digits to the right of the decimal point.

3. Perform computations. Align the decimal point in the answer with the decimal points in the problem.

Example A: 3.3 + 1 + 4.67

Step 1:

```
  3.3
  1.
+ 4.67
```

Steps 2 and 3:

```
  3.30
  1.00
+ 4.67
------
  8.97
```

Example B: 11.5 - 8.25

Step 1:

```
 11.50
- 8.25
```

Steps 2 and 3:

```
 11.50
- 8.25
------
  3.25
```

Possible Instructional Activities

Total It

Bring in several canned or packaged food items with their prices. Read the prices to students, and have them total the "bill" on scratch paper. Next, pretend that you have a "cents off" coupon for one or two items. Have students subtract the specified amount of the coupon(s) from the previous total. Ask for volunteers to demonstrate the correct solutions on the board.

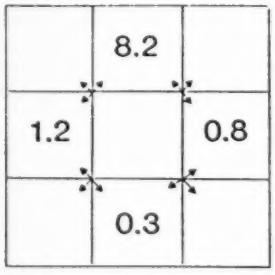
Puzzle Squares

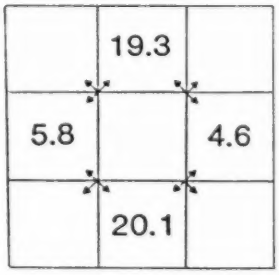
For this activity students complete the puzzles shown below. Each puzzle contains four number boxes and five empty boxes. The object is to fill in the empty boxes of each puzzle using the following steps:

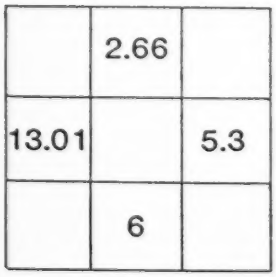
1. Add the two numbers contained in each pair of squares that are joined by an arrow. Write the sum in the corner square between the two numbers. Fill in all four corners. For example, in the first square shown below, the sum of 8.2 + 0.8 would be placed in the upper right hand corner.

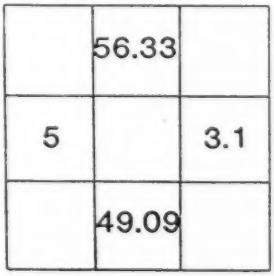
2. Then add the two numbers that are in opposite, diagonal corner squares. Do the same for the numbers in the other diagonal pair of squares. Both sums should be the same. If so, write the answer in the center square. If they don't agree, an error has been made, and the work should be rechecked.

3. To check your solution, add the original four puzzle numbers together. This answer must be the same as the number in the center of the puzzle.









Objective 4: Multiply whole numbers less than 1000.

This objective requires students to solve multiplication problems involving whole numbers.

Sample Item

$$\begin{array}{r} 258 \\ \times\ 17 \end{array}$$

A. 2064

B. 4336

C. 4386

D. 4384

Test Questions

1. A test item will be a problem in which a whole number of three digits or less is multiplied by a whole number of two digits or less.

2. The problems will be presented in a vertical format.

Answer Choices

1. The correct answer choice will be the exact solution to the multiplication problem presented.

2. Incorrect answer choices are likely to result from one or more of the following types of errors:

   a. Computation Error: An error in the multiplication of two numbers.

   b. Regrouping Error: Failing to regroup when necessary, regrouping incorrectly, or regrouping unnecessarily.

   c. Misaligned Digit: Misaligning partial products.

Answer Analysis for Sample Item

1. Answer choice A is incorrect because the digits were misaligned in the second partial product, as illustrated. A "place holder" zero is needed in the far right position of the second partial product.

$$\begin{array}{r} 258 \\ \times\ 17 \\ \hline 1806 \\ 258 \quad \text{(error)} \\ \hline 2064 \end{array}$$

2. Answer choice B is incorrect because there is a regrouping error in the first partial product, as illustrated. (error)

```
  258
x 17
1756
2580
4336
```

3. Answer choice C is the correct response, as illustrated. The multiplication is accurate, the digits are correctly aligned, and the partial products are added properly.

```
  258
x 17
1806
2580
4386
```

4. Answer choice D is incorrect because there is a computation error in the first partial product, as illustrated. (error)

```
  258
x 17
1804
2580
4384
```

Instructional Emphases

Although introduced at earlier grade levels, it may be helpful to provide students with a brief conceptual review of multiplication. Describe the connection between counting, adding, and multiplying with an example such as the following: 3 boxes contain 20 objects each. To determine the total number of objects, one can count (1, 2, 3, ..., 60), add (20 + 20 + 20 = 60), or multiply (20 x 3 = 60). Hence, multiplication can simply be thought of as repeated addition (3 x 20 = 20 + 20 + 20). Make certain that students have mastered the single-digit multiplication table.

In presenting students with multiple-digit multiplication problems, discuss the appropriate steps with emphasis on regrouping and aligning partial products. Remind students that in regrouping, multiplication is performed before adding the carried number to the product. Also, to ensure correct alignment of partial products, tell students to write a place-holder zero in the far-right of the second partial product before performing the computations. Explain that the place holder zero is required because the second partial product is the product of the first factor multiplied by the tens place value of the second factor. For example:

```
 258        258        258
x 17   =   x  7   +   x 10
1896 <---  1806        2580
2580 <-----------------┘
4386
```

Work through numerous sample problems with the class, using a step-by-step approach. Start with problems involving multiplication of a two-digit factor by a one-digit factor. Gradually increase the difficulty of problems to include multiplication of a three-digit factor by a two-digit factor.

Possible Instructional Activities

Mix and Match

Distribute the following problems to students for practice.

Match the multiplication problems on the left side of the page with the correct answers on the right side by drawing a line, as shown.

18 x 9 = 162	3281
193 x 17 = ___	616
803 x 6 = ___	4176
56 x 11 = ___	162
99 x 10 = ___	990
75 x 68 = ___	5874
232 x 18 = ___	4818
58 x 35 = ___	5100
89 x 66 = ___	50463
801 x 63 = ___	2030

Palindromes Are Special Numbers

Tell students that numbers which read the same forward and backward are called palindromes. The answer to each of these problems is a palindrome.

121 x 11	301 x 51
69 x12	62 x14

56 x11	25 x21
174 x 4	37 x 3

Which Would You Choose?

Write the following pairs of problems on the chalkboard. Tell students to imagine that the problems in a pair represent two options from which to choose. Before the problems are solved, ask students which option they would prefer. Then, have a student come to the board and perform the multiplication. Now, ask students which option they would choose and why.

16 bags of candy x 8 pieces in each bag ___ pieces of candy	or	19 bags of candy x 7 pieces in each bag ___ pieces of candy
27 toys in a box x 3 boxes ___ toys		25 toys in a box x 4 boxes ___ toys
805 gold coins in a treasure chest x 6 treasure chests ____ gold coins	or	850 gold coins in a treasure chest x 5 treasure chests ____ gold coins
43 records in a box x 8 boxes ___ records	or	41 records in a box x 9 boxes ___ records
36 watches in a bag x 5 bags ___ watches	or	31 watches in a bag x 6 bags ___ watches

Objective 5: Divide whole numbers that have four or fewer digits.

This objective requires students to solve division problems involving whole numbers.

Sample Item

$45\overline{)4725}$

A. 105 r 25

B. 15

C. 105 r 20

D. 105

Test Questions

1. Numbers will not be larger than a four-digit whole number divided by a two-digit whole number. Some problems will have remainders; others will not.

2. Dividends will not have zeros in both the tens and hundreds place. In the two-digit divisors, each digit will have a value of five or less.

3. Items will be presented in the form $Y\overline{)X}$.

Answer Choices

1. The correct answer choice will be the exact solution to the division problem presented.

2. Remainders will be expressed as "r."

3. Incorrect answer choices are likely to result from one or more of the following types of errors:

   a. Computation Error: An error in the division of two numbers.

   b. Regrouping Error: Failing to regroup when necessary, regrouping incorrectly, or regrouping unnecessarily.

   c. Place Value Error: Failure to retain the place value of zero.

Answer Analysis for Sample Item

1. Answer choice A is incorrect because there is a computation error, as illustrated. An error was made when 5 was multiplied by 45. The product should be 225, not 200. This yields the error in the final answer.

```
          105 r 25
45)4725
   45
   22
    0
   225
(error) 200
    25
```

2. Answer choice B is incorrect because there is a place value error. When 22 was divided by 45, the answer (0) was not placed in the quotient. This yields the final answer of 15 rather than 105.

3. Answer choice C is incorrect because of a regrouping error, as illustrated. The error occurred when 5 was multiplied by 45. There was a failure to regroup to the hundreds place.

```
          105 r 20
45)4725
   45
   22
    0
   225
(error) 205
    20
```

4. Answer choice D is the correct response, as illustrated. All operations are accurately performed, yielding the correct response of 105.

```
          105
45)4725
   45
   22
    0
   225
   225
     0
```

Instructional Emphases

You may want to provide some background review of division for students. Explain that division involves breaking down one large group into a number of smaller groups. Objects such as paper clips or crayons may be used to illustrate this concept. Present students with simple division problems (for example, $18 \div 3$, $20 \div 4$, $24 \div 6$) and demonstrate each solution by having students separate the specified number of objects (the dividend) into the specified number of groups (the divisor).

In presenting students with division problems, it is important to consider that the procedure for division uses multiplication and subtraction. Thus, students should be well skilled in those two operations before tackling division. When introducing division calculations, you may find it helpful to present the following steps and examples.

Solve: $7\overline{)91}$

- **1st Digit** — Divide. (How many 7's in 9?) Multiply. Subtract and Compare (resulting number must be smaller than divisor).

$$\begin{array}{r} 1 \\ 7\overline{)91} \\ -\,7 \\ \hline 2 \end{array}$$

- **2nd Digit** — (Bring down the next digit.) Divide. Multiply. Subtract and Compare.

$$\begin{array}{r} 13 \\ 7\overline{)91} \\ -\,7 \\ \hline 21 \\ \underline{21} \\ 0 \end{array}$$

- **Check** your work by multiplying.

$$\begin{array}{r} 13 \\ \times\ 7 \\ \hline 91 \end{array}$$

Expand on this procedure by using larger numbers as divisors and dividends.

Solve: $13\overline{)275}$

- **1st Digit** — Divide. (How many 13's in 2?) None. Go on.

$$13\overline{)275}$$

- **2nd Digit** — Divide. (How many 13's in 27?) Multiply. Subtract and Compare.

$$\begin{array}{r} \quad 2 \\ 13\overline{)275} \\ -\,26 \\ \hline 1 \end{array}$$

- **3rd Digit** — Divide. Multiply. Subtract and Compare (2 is less than 13).

$$\begin{array}{r} 21\text{ r }2 \\ 13\overline{)275} \\ -\,26 \\ \hline 15 \\ -\,13 \\ \hline 2 \end{array}$$

- Check

```
  21
x 13
  63
+ 210
 273
+  2   remainder
 275
```

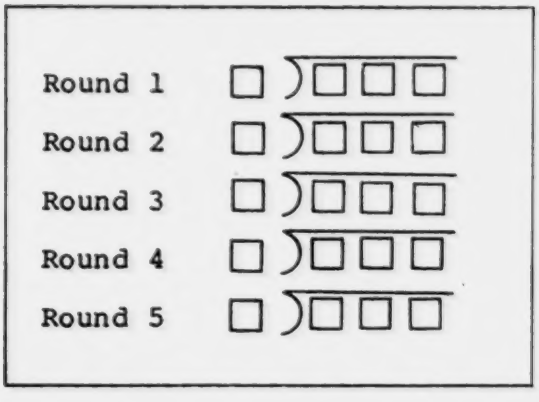
Possible Instructional Activities

Divide and Conquer

Split the class into two or more teams. Have one player from each team go to the front of the class. Present a division problem (for example, 384 ÷ 16). Let the players think about the problem for about 30 seconds, and then ask each player to guess the answer. Meanwhile students at their desks can be solving the problem on scratch paper. Then, have the players work together and solve the problem on the board. The player whose guess is closest to the correct answer wins a point for his or her team. Continue playing in this manner until every student has had a chance to play. Remember to alternate the order in which players present their guesses. For example, if a Team A player was allowed to guess first in Round 1, then a Team B player should get the first guess in Round 2. The team with the most points at the end of the game is the winner.

Creative Division

Provide students with a page of "problems" like those shown below. Read aloud four numbers from 1 through 9. Have students write the numbers in any box labeled Round 1. After all four digits have been provided, students should perform the division. The student with the largest (or smallest) answer in the quotient wins the round.



Puzzling Numbers

Write this activity on the chalkboard or copy and distribute it to students.

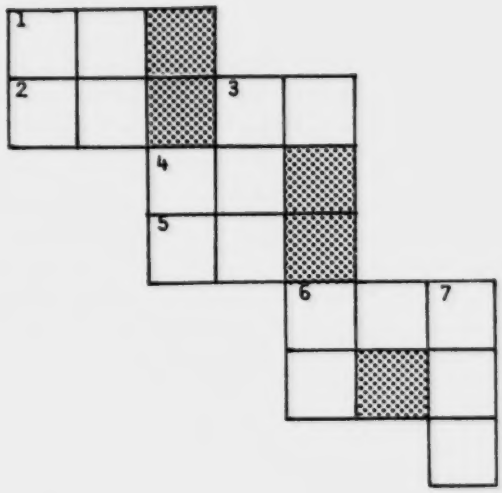
Do the division and place your answers in the puzzle.

Across

1. $9\overline{)459}$
2. $12\overline{)984}$
3. $15\overline{)645}$
4. $4\overline{)276}$
5. $7\overline{)343}$
6. $2\overline{)802}$

Down

1. $11\overline{)638}$
3. $2\overline{)998}$
4. $13\overline{)832}$
6. $18\overline{)792}$
7. $5\overline{)580}$



SKILL AREA: PROBLEM SOLVING

The skill area of problem solving includes three objectives: word problems requiring addition and subtraction, word problems requiring multiplication and division, and word problems requiring the use of decimals.

Objective 6: Solve two-step word problems involving addition/subtraction of whole numbers.

This objective requires students to solve two-step word problems involving the addition and subtraction of whole numbers.

Sample Item

In the school library there were 649 books at the start of the day. During the day 52 books were borrowed. Also, 137 books were returned. How many books were in the library at the end of the day?

A. 734 books

B. 460 books

C. 838 books

D. 724 books

Test Questions

1. A test item will require the use of two computations involving addition or subtraction with whole numbers no greater than three digits in length.

2. A test item will contain a separate sentence corresponding to each operation that is required.

3. There will be no irrelevant numerical information in a test item.

4. Test items will not involve the use of money.

Answer Choices

1. All answer choices will be labeled in the appropriate units.

2. The correct answer choice will be the exact solution to the problem presented.

3. Incorrect answer choices are likely to result from one or more of the following types of errors:

   a. Computation Error: An error in either the addition or subtraction of the numbers.

   b. Regrouping Error: Failing to regroup when necessary, regrouping incorrectly, or regrouping unnecessarily.

   c. Missing Operation: Not operating on the data or omitting one of the required operations.

   d. Incorrect Operation: Performing an operation other than a required one.

Answer Analysis for Sample Item

1. Answer choice A is the correct response to the test item, as illustrated below:

Step 1:			Step 2:		
	649			597	
	- 52	borrowed books		+137	returned books
	597			734	

2. Answer choice B is an incorrect choice because of the use of a wrong operation. The number of returned books was subtracted rather than added, as shown:

Step 1: (no error)			Step 2: (error: wrong operation)		
	649			597	
	- 52	books borrowed		-137	returned books
	597			460	

3. Answer choice C is also incorrect because of an incorrect operation. The number of borrowed books was added rather than subtracted, as illustrated below:

Step 1: (error: wrong operation			Step 2: (incorporates error in Step 1)		
	649			701	
	+ 52	borrowed books		+137	returned books
	701			838	

4. Answer choice D is incorrect because of a computation error in Step 1. After regrouping in the tens place, an incorrect calculation (14 - 5 = 8) is performed, yielding the incorrect answer.

Instructional Emphases

Central to solving word problems is determining what operations are needed for what numbers. Another important step is to look over the problem to see whether the answer is reasonable,

given the requirements of the problems. You may wish to review the following step-by-step procedure for solving word problems with your students.

a. Read the problem carefully. Pay attention to what the question asks.

b. Decide what operations are needed and how to perform them. Make sure the solution uses every number in the problem.

c. Compute the answer carefully. Double-check the calculations.

d. Look back at the problem and decide if the answer seems reasonable.

Possible Instructional Activities

Check It Out

Create word problems from objects and situations that are familiar to students. Provide several possible answers and have the students guess what the answer could be without solving the problem. For example:

> There were 20 students in the class. Then, 8 new students joined the class. Later, 4 students moved away. How many students are now in the class?

a. 10 students

b. 48 students

c. 24 students

d. 60 students

Explain to students that estimation skills should be developed because an estimate will tell whether or not a calculated answer is reasonable. As students develop skill at estimating the answers, give them word problems that require more difficult estimation tasks and allow less reliance on the context. An example can be seen on the following page.

The tiny town of Muggs has a population of 437 residents. Recently a new company settled in Muggs and brought 88 new residents. About the same time, 21 people moved away. How many people live in Muggs now?

a. 504 people

b. 88 people

c. 854 people

d. 116 people

After students have estimated the answers, have them solve the problems on paper and compare their estimates to the actual answers.

Judge a Problem

Divide the class into 3 groups: 2 competing teams and 1 team of judges. Write a description of a word-problem situation on the board. Have prepared a variety of questions relating to the situation which require computations. Do not write these questions on the board. For example:

Word-Problem Situation

Carmen, Richard, and Bill belong to a stamp collectors club at school. Carmen has 31 stamps, Richard has 16 stamps, and Bill has 28 stamps.

Questions

1. How many stamps would the students have if they put all their stamps together? (addition)

2. If Carmen got 5 new stamps, and gave 2 old stamps to Richard, how many stamps would Carmen have then? (addition, subtraction)

3. If Richard lost 3 stamps, and Bill gave Richard 1 stamp, how many stamps would Richard have? (subtraction, addition)

4. If Bill gave 6 stamps to his younger brother, how many would Bill have left? (subtraction)

Tell the competing teams that you (or one of the judges) will read questions relating to the situation described on the board, one at a time. The students on each competing team are to compute the answer to each question as fast as possible and raise their hands when they finish. The first person who gives the

correct answer to a question wins a point for his or her team. The team with the most points at the end of the round of questions wins. Judges must also solve each problem in order to ascertain which are the correct answers. Moreover, judges determine whose hand is raised first and keep score. Conduct three rounds with different word problems so that each group has a chance of competing against every other group.

Math Mysteries

Give students a series of word problems with an answer provided. Tell them that some of the answers are correct, and others are not. The students' first task is to compute the correct answer. Then, if that answer is different from the answer that was given, students must find out what error was made that resulted in the incorrect answer. Give students a list of possible errors in advance, and explain what each error type means. After solving one or more problems, go over the incorrect answers and discuss how the error could have been avoided. Use the following error types:

> Missing operation: not performing a necessary computation. Solution: Read more carefully, watch for words that signal a computation, and decide whether your answer is reasonable.
>
> Incorrect operation: using the wrong operation such as adding when subtraction was required. Solution: Pay attention to the question in the word problem, read the problem carefully for signals as to the correct calculations, and decide whether your answer is reasonable.
>
> Computation error: making an error in calculation. Solution: Check and double-check your work.

An example of the problems might be:

> Workers were replacing 87 old telephone poles with new ones. When they had replaced 57 old poles, a storm knocked down 6 of the new poles. How many poles do the workers still have to put up?
>
> Incorrect answer: 24 poles
> Source: an incorrect operation (87-57-6 rather than 87-57+6)
>
> Correct answer: 36 poles

You can use your regular sources of word problems for this exercise, and simply replace some of the right answers with wrong ones based on the error types above.

Objective 7: Solve one-step word problems involving the multiplication/division of whole numbers.

This objective requires students to solve word problems involving the multiplication or division of whole numbers.

Sample Item

The gas station has 15 cases of motor oil. Each case contains 12 cans of oil. How many cans of motor oil does the gas station have?

A. 27 cans

B. 180 cans

C. 45 cans

D. 170 cans

Test Questions

1. A test item will present a word problem that requires only one multiplication or division operation to solve.

2. In division problems, the dividend will be no more than three digits, and the divisor will be one digit. Division problems will not result in remainders.

3. In multiplication problems, the factors will have no more than two digits.

4. Each piece of numerical information will be contained in its own sentence. There will be no extraneous numerical information in the problems. Problems will not involve money.

Answer Choices

1. Answer choices will be labeled appropriately.

2. The correct answer will be the exact solution to the problem presented.

3. Incorrect answers are likely to result from one or more of the following types of errors:

   a. Computation Error: An error in the multiplication or division of two numbers.

   b. Regrouping Error: Failing to regroup when necessary, regrouping incorrectly, or regrouping unnecessarily.

c. Misaligned Digit: Either (1) adding or subtracting a digit in one place to or from a digit in an adjacent place or (2) misaligning partial products.

d. Missing Operation: Not operating on the data or omitting one of the required operations.

e. Incorrect Data Error: Performing a necessary operation on the wrong data.

f. Incorrect Operation: Performing an operation other than a required one.

Answer Analysis for the Sample Item

1. Answer choice A is incorrect because an incorrect operation is used. Instead of multiplication, addition is used (15 + 12 = 27).

2. Answer choice B is the correct response. The correct operation is selected, and the operation is carried out accurately, as illustrated below:

$$\begin{array}{r} 15 \text{ cases} \\ \times\ 12 \text{ cases} \\ \hline 30 \\ 150 \\ \hline 180 \text{ cases} \end{array}$$

3. Answer choice C is incorrect because of a misaligned digit in the second partial product, as illustrated below:

$$\begin{array}{rr} & 15 \\ & \times\ 12 \\ \hline & 30 \\ \text{(error)} & 15 \\ \hline & 45 \end{array}$$

4. Answer choice D is incorrect due to a regrouping error in the first partial product, as illustrated below:

$$\begin{array}{rr} & 15 \\ & \times\ 12 \\ \hline \text{(error)} & 20 \\ & 150 \\ \hline & 170 \end{array}$$

Instructional Emphases

For this objective, students must be able to recognize what operation is required to solve the problem. Thus, instruction and practice on translating word problems into computations may be helpful. Students need to know how to select the appropriate operation and perform the calculations. Presented below is a step-by-step procedure for solving word problems that you may want to review with students.

1. Read the problem.

   Read the problem carefully to determine what the problem is about. Pay particular attention to the question being asked.

2. Determine what computation must be performed.

   Based on the question, determine exactly what computations are required to solve the problem.

3. Perform the computation.

   Perform the computations. Double-check your computations to make sure they are accurate.

4. Decide if the answer is reasonable.

   Look over the problem, and decide whether your answer is sensible given the situation presented in the problem. If your answer seems unreasonably large or small, reread the problem and start again.

The sample item can be used to illustrate each of the steps described above:

Step 1: The problem is about motor oil. The question asks how many cans of motor oil the gas station has.

Step 2: The numerical information in the problem is:
a. 15 cases of motor oil, and
b. 12 cans of oil per case

Step 3: To find the total number of cans, multiply the numbers:

```
  15 cases of oil
x 12 cans of oil per case
  30
 150
 180 cans of oil
```

Step 4: The answer seems reasonable, given the information in the problem.

Possible Instructional Activities

Decision Drill

Instruct students to number a piece of paper from 1 to 5. Read the following one-step word problems that require either multiplication or division. Have students write down which operation (that is, multiplication or division) they think should be used to solve each problem.

1. Mervin has 80 stuffed animals to give away. He wants to give an equal number to each of 5 small children. How many stuffed animals should each child get?

2. There are 27 teachers at Cherry Blossom Elementary School. Each teacher has 24 students. How many students are there at Cherry Blossom Elementary School?

3. There are 13 cases of soft drinks for the festival. Each case contains 24 cans of soft drinks. How many cans of soft drinks are there for the festival?

4. Leslie has 96 tools to put away. She wants to put the same number of tools in each of 6 drawers. How many tools should she put in each drawer?

5. Mr. Ram has 39 boxes of greeting cards. Each box contains 15 cards. How many cards does Mr. Ram have?

After you have read all the problems, ask students to identify which operation they chose for each problem. Have volunteers demonstrate the solution to the problems on the chalkboard or with manipulatives.

Concrete Operations

Ask a volunteer to use manipulatives to "act out" (demonstrate) a word problem that you present orally. Word problems such as the following could be used:

Peggy buys 4 boxes of pencils. Each box contains 30 pencils. How many pencils did Peggy buy?

A group of 3 children share the cost of a bag of bubble gum. There are 51 pieces of gum in the bag. If each child gets an equal number, how many pieces of gum should each child receive?

There are 12 rows of chairs in the auditorium. In each row are 15 chairs. How many chairs are in the auditorium?

Have the first volunteer select a second volunteer to demonstrate the next problem, and so on.

Garden Work

Use growing a garden as a situation for creating word problems. Give students a series of problems about gardens that require multiplication and division, or have students create problems for their classmates to solve. Alternatively, you could instruct groups of students to design a garden and perform all the calculations associated with planting and fertilizing. Make certain that the problems require multiplication or division. Only one operation should be required for each problem. Some sample problems are provided below.

If your garden has 6 rows and you want to grow 18 tomato plants, how many plants would be in each row if they were distributed evenly?

If your garden has 4 rows and you put 9 carrot plants in each row, how many carrots would you grow?

If your garden has 20 rows and you are supposed to put two bags of fertilizer on each row, how many bags will you need?

Each of your pea plants yields 40 pea pods. If you grew 5 pea plants, how many pods did you grow?

In one row of your garden you want to plant corn. If the row is 40 feet long and you place the corn plants 2 feet apart, how many plants will you need?

Objective 8: Solve one-step word problems involving addition/subtraction of decimals.

This objective requires students to solve one-step word problems that involve either addition or subtraction of decimals.

Sample Item

Sandra bought a board game for $8.59 and a puzzle for $3.25. How much money did she spend?

A. $12.84

B. $ 5.34

C. $11.84

D. $11.85

Test Questions

1. A test item will present a word problem whose solution requires one addition or one subtraction operation using decimal numbers. Each item will contain numbers that have the same number of digits to the right of the decimal point. The number of digits to the right of the decimal point will not exceed two.

2. Some items will involve money.

3. No extraneous data will be presented in the test items.

Answer Choices

1. The correct answer choice will be the exact solution to the problem presented.

2. Incorrect answer choices are likely to result from one or more of the following types of errors:

   a. Computation Error: An error in the addition or subtraction of two numbers.

   b. Regrouping Error: Failing to regroup when necessary, regrouping incorrectly, or regrouping unnecessarily.

   c. Incorrect Operation: Performing an operation other than the required one.

d. Misplaced Decimal Point: Placing the decimal point in an incorrect position on either a correct solution or an incorrect solution.

e. Place Value Error: Failure to retain the place value of zero.

Answer Analysis for Sample Item

1. Answer choice A is incorrect because of a regrouping error. It appears that a 1 was unnecessarily carried to the ones place, as illustrated.

$$\begin{array}{r} 8.59 \\ +\ 3.25 \\ \hline 12.84 \end{array}$$

2. Answer choice B is incorrect because subtraction was performed instead of addition.

3. Answer choice C is the correct response. The problem is set up correctly, and the addition is accurate, as illustrated below.

$$\begin{array}{r} 8.59 \\ +\ 3.25 \\ \hline 11.84 \end{array}$$

4. Answer choice D is incorrect because of a computation error in the hundredths place. The sum of 9 and 5 is 14, not 15.

Instructional Emphases

An essential skill in this objective is the translation of word problems into the appropriate mathematical operations. Students need to recognize when addition or subtraction is required to solve a given problem. You may want to review with students the overall step-by-step procedures for solving word problems as presented in Objective 6.

Students should be aware that computations for decimal operations are performed in exactly the same way as the corresponding whole number operations. Remind students that a whole number can also be written as a decimal number with the decimal point placed to the right of the ones place (for example, 12 = 12.00). Students should know how to align decimal points when setting up addition and subtraction problems in vertical format. In this objective, the numbers in each problem have the same number of places to the right of the decimal. Thus, students can check that their computations maintain the same number of places to the right of the decimal as the numbers presented in the problem.

Possible Instructional Activities

Food for Thought

Bring in a fast-food menu or present a hypothetical one as shown below. Use the menu to construct word problems involving the prices of different combinations of food (for example, a hamburger and onion rings) or the differences in prices between items (for example, a large order of fries versus a small order). You may also want to develop word problems that require students to compute the change they would receive when using a 10- or 20-dollar bill to buy a specific item on the menu.

Mike's Hamburger Haven

Menu

Hamburger	$ .99	Soft drinks:	
Cheeseburger	$1.19	Small	$ .60
Double hamburger	$1.89	Medium	$ .80
Double cheeseburger	$2.09	Large	$1.00
Onion rings	$ .85		
French fries:			
Large	$ .85		
Small	$ .60		

Backyard Decimals

Present the following problems to students. Tell them to read each problem carefully, answer all questions by writing the correct mathematical sentence, and then solve the problem. Remind students to label their responses and check their work.

Carla and Wendy spent the weekend fixing up the backyard.

1. Carla used 22.5 feet of rope to make a swing. Wendy used 9.5 feet of rope to make a clothesline.

   a. How much rope did they use?

   _____

   b. How much more rope did Carla use than Wendy?

   _____

2. Carla painted the fence. She spent $10.79 on paint and $3.29 on brushes.

   a. How much money did Carla spend?

   _____

3. Wendy used 5.1 pounds of fertilizer for the lawn. Carla used 1.6 pounds of fertilizer for the flowers.

   a. How many pounds of fertilizer did they use?

   _____

   b. How much more fertilizer did Wendy use than Carla?

   _____

Decimal Story

Have students use magazines, newspapers, or books to find situations in which decimal numbers are used. Tell students to clip out the articles or advertisements and attach them to sheets of construction paper along with a related addition or subtraction word problem. Have some students present their problems for the class to solve. You may want to display some of the problems on the bulletin board as examples of numbers in everyday life.

SKILL AREA: MEASUREMENT

The skill area of measurement covers two objectives: estimating measurements and interpreting graphs.

Objective 9: Estimate measurements in either metric or customary units.

This objective requires students to estimate the length, weight/mass, or capacity/volume of a specified object using either metric or customary units.

Sample Item

A soft drink can holds about

A. 350 milliliters

B. 2 milliliters

C. 1 liter

D. 12 liters

Test Questions

1. A test question will require students to estimate the length, weight/mass, or capacity/volume of a specified object. The measurement units that students may be required to estimate include:

   Metric: millimeter, centimeter, meter, kilometer, milligram, gram, kilogram, milliliter, liter, kiloliter

   Customary: inch, foot, yard, mile, ounce, pound, ton, cup, pint, quart, gallon

2. Picture stimuli may be used in the test questions.

Answer Choices

1. All answer choices will be labeled in either metric or customary units. Metric and customary units will not appear in the same set of answer choices.

2. The correct answer choice will be the measurement that most accurately estimates the specified dimension of the given object.

3. Incorrect answer choices will be inaccurate estimates expressed in either the appropriate unit of measure or an inappropriate unit of measure with respect to the size of the property to be estimated.

Answer Analysis for Sample Item

1. Answer choice A is correct because it represents a reasonable estimate of the number of milliliters that can be held in a soft drink can.

2. Answer choice B is incorrect because the number of milliliters (2) is too small to be a reasonable estimate of the volume of a soft drink can.

3. Answer choice C is incorrect because a liter is too large a unit to provide a reasonable estimate of the volume of a soft drink can.

4. Answer choice D is also incorrect because the estimate is too large.

Instructional Emphases

Estimation requires students to develop an internal sense of the size of the basic units of measure. This sense can be developed through familiarity with the various units and practice at estimating actual weights, lengths, and volumes with these units. Estimation also depends upon the ability to imagine the property of objects to be estimated. Therefore, after reviewing the basic units of measure, offer students sufficient opportunities to practice estimating various dimensions for a range of common objects.

Possible Instructional Activities

Estimate and Measure

Divide the class into small groups of students. Give each group a chart to complete that contains the height, weight, and/or volume of various objects that they are to estimate in either metric or customary units. If possible, give each group a different list. An example of such a list is presented below.

Object	Property	Measurement System	Estimate	Actual Measure
Dictionary	Length	Metric	_____	_____
Math Book	Weight	Customary	_____	_____
Watering Can	Volume	Capacity	_____	_____
Chalkboard	Width	Metric	_____	_____
Johnny (or some other student)	Height	Metric	_____	_____
Baseball Bat	Weight	Customary	_____	_____
Eraser	Length	Metric	_____	_____
Shoe	Length	Customary	_____	_____

You may want to bring extra objects to the class in order to provide an appropriate range of dimensions for students to consider. After students have recorded their labeled estimates, tell them to measure the objects on their lists. Have rulers, scales, and measuring cups available for students to use. Tell students to complete the chart by recording the actual measurement next to each object listed. Ask students to compare how well their estimates agree with actual measurements.

Let's Contain It

Capacity is often considered the most difficult of the three estimation tasks. The estimation of capacity should begin with simple objects. Bring glasses of different sizes, pots, or plastic containers to class. Appropriate small objects might include thimbles, aspirin bottles, or 35mm film containers. Have students work in small groups to perform each of the following steps:

1. Line up the containers from smallest to largest.

2. Estimate the capacity of each container. (Note: The teacher should specify whether the estimate should be in customary or metric units.) Have students record their individual or group estimates.

3. Fill each container with water, then pour the water into a measuring device to determine the accuracy of the estimates.

4. Label each object with its capacity, and display the containers in the classroom for students to examine.

Estimation Event

Have an estimation contest in your classroom. Divide students into several teams. Create a committee of judges to decide what lengths, weights, and capacities of classroom objects are to be estimated in customary or metric units. Have the teams compete in rounds. For each "match," the judges designate an

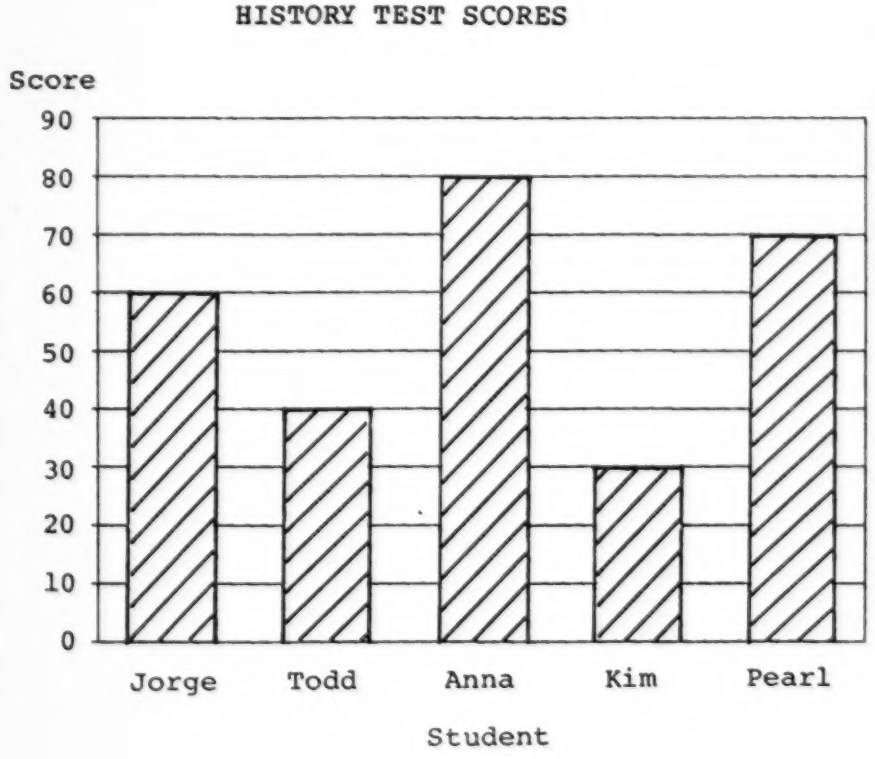
estimation problem for the competing teams. Each team is given a specified time (for example, one minute) to submit a written estimate. The judges then use measuring devices to determine the correct measurement, decide which estimate is closer to the actual measurement, and name a winner. Proceed by whatever rules you devise until a winning team is declared.

SKILL AREA: MEASUREMENT

Objective 10: Interpret graphs.

This objective requires students to interpret line, bar, and picture graphs.

Sample Item



What was the difference between Anna's score and Jorge's score on the history test?

A. 20 points

B. 30 points

C. 40 points

D. 60 points

Test Questions

1. A test item will present one of three types of graphs: line, bar, or picture graph.

2. The scale used on each graph will consist of whole unit intervals greater than one. Line and bar graphs will end at unit points.

3. Graphs will not display more than eight entries of data.

4. Items will require either comparison, computation, or other interpretation from graphs. Computations will be limited to one operation per item.

Answer Choices

1. All answer choices will be labeled with the units used in the corresponding graph.

2. Incorrect answer choices will result from one of the following types of errors:

   a. Incorrect Operation: Performing an operation other than the required one.

   b. Missing Operation: Not operating on the data or omitting the required operation.

   c. Incorrect Selection of Information: Selecting the wrong information from a graph.

   d. Scaling Error: Using a scale other than the one presented.

Answer Analysis for Sample Item

1. Answer choice A is the correct response. According to the graph, Anna's test score was 80, and Jorge's test score was 60. The difference between the two scores is 20 points.

2. Answer choice B is incorrect because of a computation error. The computation, 80 minus 60, yields 20 and not 30.

3. Answer choice C is incorrect due to the incorrect selection of data for the graph. Instead of Jorge's score, Todd's score was subtracted from Anna's score (80 - 40 = 40).

4. Answer choice D is incorrect due to a missing operation. Jorge's score (60 points) was taken directly from the graph, and no operation was performed.

Instructional Emphases

This objective requires students to either: (1) select specific information from a graph or (2) obtain information from a graph and perform a computation to answer a related question. It may be a good idea to focus your instruction primarily on how to read information from a graph, as computation skills will be covered in a variety of other objectives.

To help students learn how to interpret a graph, discuss examples of various types of graphs including the primary purpose of each:

1. Bar Graphs:

   A bar graph typically shows how different data compare, such as the number of members in different clubs or average heights of various species of trees. The bars can be compared with each other according to their relative length and can be displayed either vertically or horizontally.

2. Line Graphs:

   A line graph typically shows the change in data, such as rainfall across various years or the number of student absences in various months.

3. Picture Graphs:

   Picture graphs, like bar graphs, show how different data compare, such as the number of students in various schools. A symbol is used to represent a specified number of items. For example, the symbol could be used to represent 50 students. The number of students per school could then be represented by the number of symbols displayed.

Possible Instructional Activities

Graph Discovery

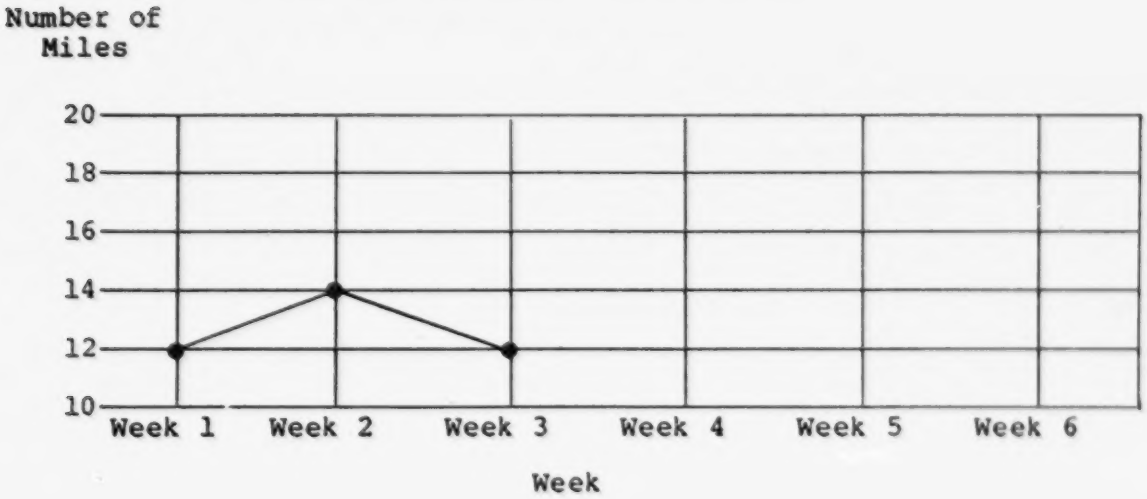
Ask students to find and bring to class either a line, bar, or picture graph from a newspaper or magazine. If photocopy equipment is available, make an overhead transparency from each graph, and have the students explain their graphs to the class. Otherwise, select several of the graphs, and present them on the chalkboard or make copies for the students to share. Use the graphs to ask questions that require students to perform a computation or find particular information on the graph.

Complete a Graph

Distribute sheets that contain incomplete graphs, such as those presented below. Have students complete the graphs by using the information provided below each graph. Ask students to make up questions about the graphs for their classmates to answer.

Graph 1

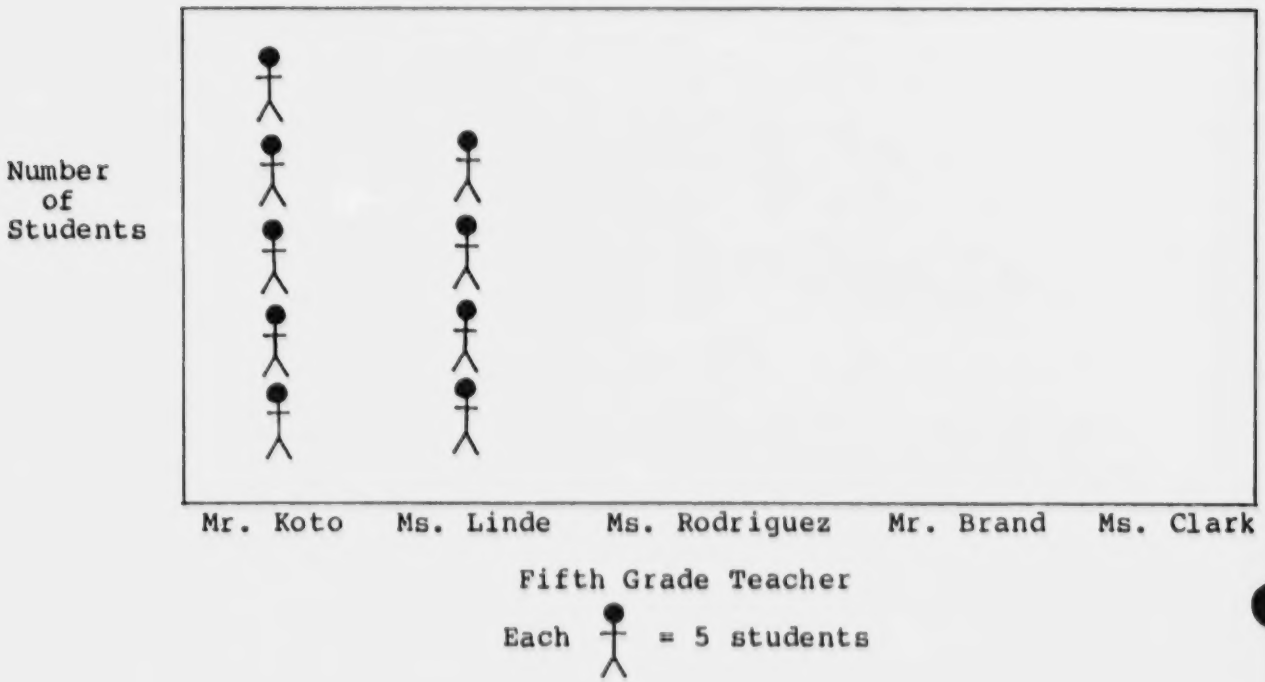
Line Graph Showing the Number of Miles
Mary Ran Each Week for Six Weeks



Week:	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Miles:	12	14	12	10	18	16

Graph 2

Picture Graph Showing the Number of Students
in Five Fifth Grade Classes



Teacher	Number of Students
Mr. Koto	25
Ms. Linde	20
Ms. Rodriguez	15
Mr. Brand	25
Ms. Clark	15

Classroom Bar Graphs

As a group activity create a large bar graph which displays information about students or school-related activities. For example, a bar graph can be used to show the number of different kinds of books read by students. Conduct a class survey to determine how many nonfiction, mystery, science fiction/fantasy, and other books were read by students during the previous month. Graph the results with students. Ask students to answer certain questions using the graph, such as: (1) How many mystery and science fiction books were read? or (2) How many more science fiction books were read than non-fiction books? Developing the graph can be a one-time activity, or the graph

could be updated on a monthly basis and displayed on a classroom bulletin board. This activity can be adapted to reflect any activity or topic that is of interest to your class. For example, students could develop graphs to record data obtained as part of a science experiment such as the growth rates of various plants. When the graph is complete, use it to ask questions which require the students to perform computations or interpretations.

SKILL AREA: GEOMETRY

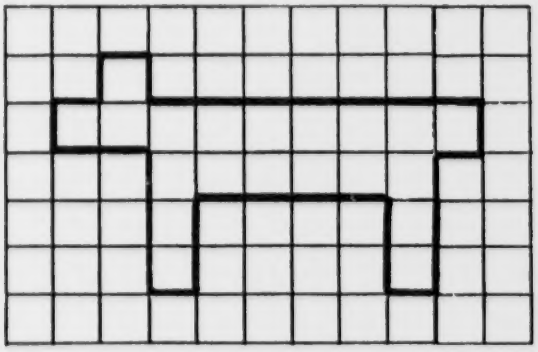
The skill area of geometry consists of one objective, namely, find the perimeter or area of polygons using grids.

Objective 11: Find the perimeter or area of polygons using grids.

This objective requires students to compute the perimeter or area of a polygon when the figure is drawn on a grid.

Sample Item

What is the PERIMETER of the polygon in the grid?



A. 20 units

B. 19 units

C. 32 units

D. 26 units

Test Questions

1. A test item will show a polygon drawn on a grid. Only whole grid units will be represented; fractions are ineligible. The number of grid units depicted in an item will not exceed 49.

2. Formulas will not accompany test items.

Answer Choices

1. All answer choices will be labeled as "units" for perimeter problems and "square units" for area problems.

2. The correct response will be the exact number of units specified by the problem.

3. Incorrect answer choices are likely to result from one or both of the following types of errors:

   a. Incorrect Procedure: Solving for area when perimeter is requested or vice versa.

   b. Counting Error: Failing to count the number of units correctly.

Answer Choice Analysis for Sample Item

1. Answer choice A is incorrect because 20 units is the area, not the perimeter of the figure presented.

2. Answer choice B is incorrect because of a combination of the two errors: 1) The area is solved for rather than the perimeter, and 2) a counting error results in 19 instead of 20 units.

3. Answer choice C is the correct response. There are 32 units along the perimeter of the figure.

4. Answer choice D is incorrect because of a counting error resulting in 26 instead of 32 units.

Instructional Emphases

The concepts of area and perimeter can be illustrated using the example of a fenced-in space. The length of the fence itself is the perimeter; all the space inside the fence is the area. Any space with well-defined boundaries (for example, a piece of paper or plot of land) can be imagined with a "fence" that forms the perimeter and an interior space that is the area. Explain that perimeter is a one-dimensional measure of length. Area, in contrast, is a two-dimensional measurement that requires both length and width. Therefore, area is measured in square units. Provide demonstrations using objects in the classroom during the explanation. For example, discuss the perimeter and area of a desk top or notebook. Place string around each object to represent the measurement of perimeter. Use blocks to represent a unit of area. Have students count the number of blocks needed to fill each space.

Emphasize to students that to determine perimeter on a grid, the line units that outline the figure must be counted. The squares of the grid are not relevant for measuring perimeter. One counting method that students may find useful is to number or check off each line unit as they count. Examples are shown below.

Figure 1

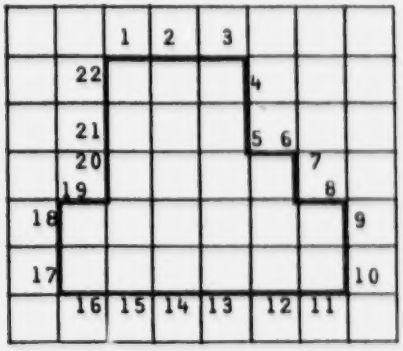
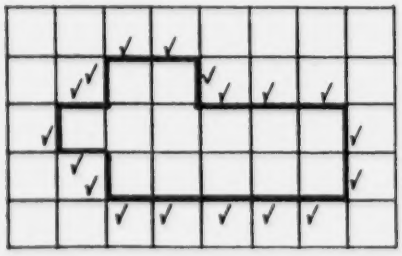


Figure 2



By using one of these methods, students will minimize the chance of counting incorrectly or of missing a line unit. Tell students to pay particular attention to counting line units when the figure turns at right angles. They must be careful to count two units for each turn, as with units 19 and 20 on Figure 1.

Area can also be computed by counting. To determine the area of a figure, students must count the square units inside the figure. Students can increase the accuracy of their counting by checking off or numbering the squares as they count them, as illustrated below:

Figure 3

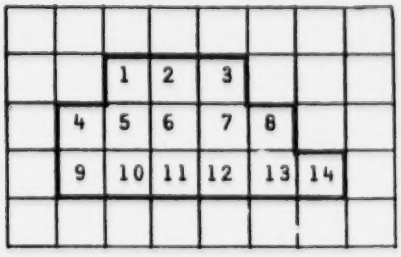
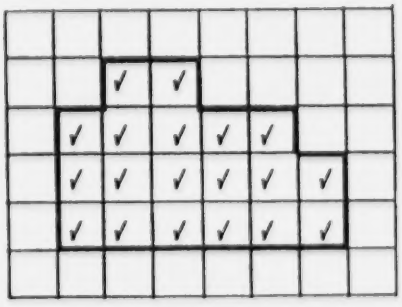


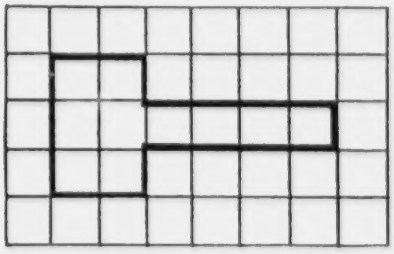
Figure 4



Possible Instructional Activities

Grid City

Create polygons that resemble classroom objects on graph paper, as shown below. Tell students to determine the perimeter and area of the polygons. Use graph paper with large squares so that the number of units per polygon can be kept to a reasonable size. Scissors, for example, would make a polygon like the one below.



String It Up

Give each student a long piece of string to use for measuring the perimeter of classroom objects. For example, have students determine the perimeter of a book by placing the string along the edges of the book. Tell students to mark the string at the point where the book is completely outlined by string. Then have students determine the actual units of the perimeter by placing the marked string alongside a yardstick. To ensure that they grasp the concept of perimeter, allow students to repeat this procedure with several appropriate objects.